Reading Molecular Clocks with femtosecond laser pulses

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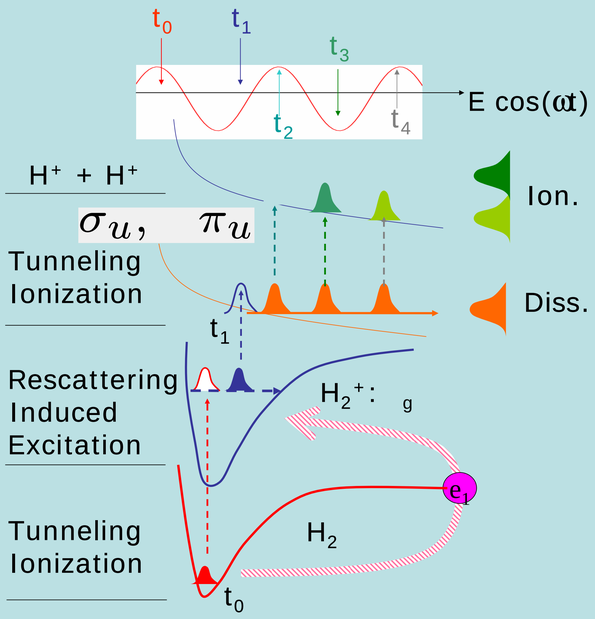
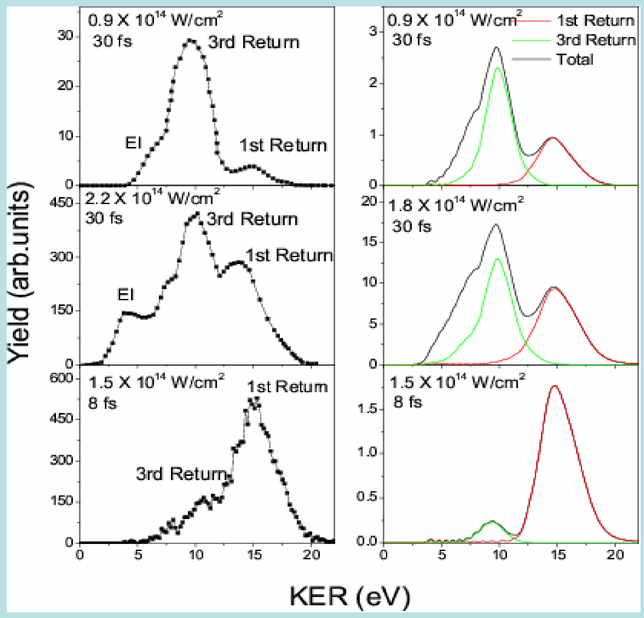
Rescattering Ionization



Rescattering double Ionization: the second ionization is from the returned electron.



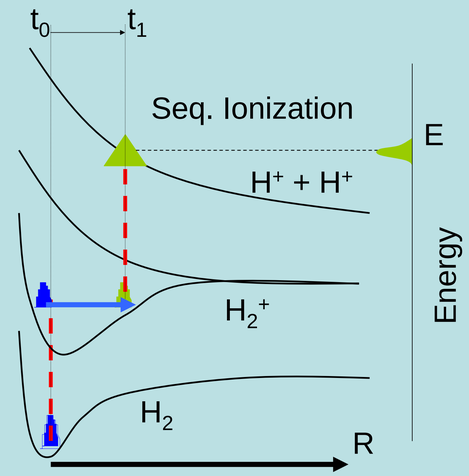
The Idea

The oscillating electric field of a laser provides the “ticks” such that the time of successive ionizations of a molecule can be read. Using hydrogen molecules, the clock starts with the first ionization and stops at the second ionization. The time interval is deduced from the measured kinetic energies of the break-up ions.

The second ionization can occur when the first electron returns to collide with the ion and ionizes it (Rescattering, left) or when the laser’s electric field reaches the peak again (sequential, right).

By changing laser’s pulse intensity and/or pulse duration, we can control the time interval between the two ionizations. The sharpness of the kinetic energy peaks shows that the clock can be read to better than 1 fs accuracy.

Sequential Ionization



sequential double ionization: the second ionization is from the laser’s electric field.